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PHOTOGRAPHED FOR THE JOURNAL BY MR. J. E. MAYALL.

PROFESSOR D. E. HUGHES.

DAVID EDWIN HUGHES was born in London in 1831. His parents came from Balla, at the foot of Snowdon, in North Wales, and in 1838, when David was seven years old, his father, taking with him his family, emigrated to the United States, and became a planter in Virginia. The elder Mr. Hughes and his children seem to have inherited the Welsh musical gift, for they were all accomplished musicians. While a mere child, David could improvise tunes in a remarkable manner, and when he grew up this talent attracted the notice of Herr Hast, an eminent German pianist in America, who procured for him the professorship of music in the College of Bardstown, Kentucky. Mr. Hughes entered upon his academical career at Bardstown in 1850, when he was nineteen years of age. Although very fond of music and endowed by nature with exceptional powers for its cultivation, Professor Hughes had, in addition, an inborn liking and

fitness for physical science and mechanical invention. This duality of taste and genius may seem at first sight strange; but experience shows that there are many men of science and inventors who are also votaries of music and art. The source of this apparent anomaly is to be found in the imagination, which is the fountain-head of all kinds of creation.

Professor Hughes now taught music by day for his livelihood, and studied science at night for his recreation, thus reversing the usual order of things. The college authorities, knowing his proficiency in the subject, also offered him the Chair of Natural Philosophy which became vacant; and he united the two seemingly incongruous professorships of music and physics in himself. He had long cherished the idea of inventing a new telegraph, and especially one which should print the message in Roman characters as it is received. So it happened that one evening while he was in the glow and enthusiasm of musical improvisation, the solution of the problem flashed into his ken. His music and his science had met at this nodal point.

All his spare time was thenceforth devoted to the development of his design and the construction of a practical type-printer. And as the work grew upon him he became more and more engrossed with it, until his nights were almost entirely given to experiment. He begrudged the time which had to be given to teaching his classes; and the fatigue was telling upon his health, so in 1853 he removed to Bowlingreen, in Warren Co., Kentucky, and acquired more freedom by taking pupils.

The main principle of his type-printer was the printing of each letter by a single current; the Morse instrument, the only other rival then in the field in America, required, on the other hand, an average of three currents for each signal. In order to carry out this principle it was necessary that the sending and receiving apparatus should keep in strict time with each other, or be synchronous in action; and to effect this was the prime difficulty which Prof. Hughes had to overcome in his work. In estimating the Hughes' Type-Printer as an invention we should never forget the state of science in those days, a quarter of a century ago. He had to find his own governors for the synchronous mechanism, and here his knowledge of acoustics helped him. Centrifugal governors and pendulums would not do, and he tried vibrators, such as piano-strings and tuning-forks. He at last found what he wanted in two darning needles borrowed from an old lady in the house where he lived. These steel rods fixed at one end vibrated with equal periods, and could be utilised in such a way that the printing wheel could be corrected into absolute synchronism by each signal current.

In 1854, Prof. Hughes went to Louisville to superintend the making of his first instrument; but the first patent for it was not taken out in the United States until 1855. In that form straight vibrators were used as governors, and a separate train of wheelwork was employed in correcting: but in later forms the spiral governor was adopted, and the printing and correcting is now done by the same action. In 1855, the invention may be said to have become a practical success, and no sooner was this the case, than Prof. Hughes received a telegram from the editors of the American Associated Press, summoning him to New York. The American Telegraph Company, then the leading one, was in possession of the Morse instrument, and levied rates for transmission of news which the editors could no longer stand. They therefore took up the Hughes instrument in opposition to the Morse. A company was formed, and the lines of the smaller fry of companies—among which was the Western Union Company, then doing business on a poor scale out West—were leased. After a time, they united in 1857 with these smaller companies to form one large corporation, the Western Union Telegraph Company of to-day. They bought over the Morse instrument too, and when the monopoly was all in their hands, the editors were again left in the lurch.

In 1857, Prof. Hughes, leaving his instrument in the hands of the Western Union Telegraph Company, came to England to effect its introduction here. He endeavoured to get the then Electric Telegraph Company to adopt it, but after two years of indecision on their part, he went over to France in 1860, where he met with a more encouraging reception. The French Government Telegraph Administration became at once interested in the new receiver, and a commission of eminent electricians, consisting of Du Moncel, Blavier, Froment, Gaugain, and other practical and theoretical specialists, was appointed to decide on its merits. The first trial of the type-printer took place on the Paris to Lyons circuit, and there is a little anecdote connected with it which is worthy of being told. The instrument was started, and for a while worked as well as could be desired; but suddenly it came to a stop, and to the utter discomfiture of the inventor he could neither find out what was wrong, nor get the printer to go again. In the midst of his confusion, it seemed like satire to him to hear the commissioners say, as they smiled all round, and bowed themselves gracefully off, "*Tres-bien, Monsieur Hughes—tres-bien. Je vous felicite.*" But the matter was explained next morning, when Prof. Hughes learned that the transmitting clerk at Lyons had been purposely instructed to earth the line at the time in question, to test whether there was no deception in the trial, a proceeding which would have been strange, had not the occurrence of a sham trial some months previous rendered it a prudent course. The result of this trial was that the French Government agreed to give the printer a year of practical work on the French lines, and if found satisfactory, it was to be finally adopted. Daily reports were furnished of its behaviour during that time, and at the expiration of the term it was adopted, and Prof. Hughes was constituted by Napoleon III. a Chevalier of the Legion of Honour.

The patronage of France paved the type-printer's progress into almost all other European countries; and the French agreement with Prof. Hughes. respecting it became the model of those of other nations. On settling with France in 1862, Prof. Hughes went to Italy. Here a commission was likewise appointed, and a period of probation—only six months—was settled, before the instrument was taken over. From Italy Prof. Hughes received the Order of St. Maurice and St. Lazare.

In 1863, the United Kingdom Telegraph Co., England, introduced the type-printer in their system.

In 1865, Prof. Hughes proceeded to Russia, and

in that country his invention was adopted after six months' trial on the St. Petersburg to Moscow circuit. At St. Petersburg he had the honour of being a guest of the Emperor's in the summer palace, Czrarskoizelo, the Versailles of Russia, where he was requested to explain his invention, and also to give a lecture on electricity to the Czar and his court. He was there created a Commander of the Order of St. Anne.

In 1865, Professor Hughes also went to Berlin and introduced his apparatus on the Prussian lines. In 1867, he went on a similar mission to Austria, where he received the Order of the Iron Crown; and to Turkey, where the then Sultan bestowed on him the Grand Cross of the Medjidie. In this year, too, he was awarded at the Paris Exhibition of 1867, a grand *hors ligne* gold medal, one out of ten supreme honours designed to mark the very highest achievements. On this occasion, also, another of these special medals was bestowed on Cyrus Field and the Atlantic Telegraph Company. In 1868, he introduced it into Holland; and in 1869, into Bavaria and Wurtemburg, where he obtained the noble Order of St. Michael. In 1870, he also installed it in Switzerland and Belgium.

Coming back to England, the Submarine Telegraph Company adopted the type-printer in 1872, when they had only two instruments at work. They have now (1878) twenty of them in constant use, of which number nine are working direct between London and Paris, one between London and Berlin, one between London and Cologne, one between London and Antwerp, and one between London and Brussels. All the continental news for the *Times* and the *Daily Telegraph*, is received by the Hughes type-printer, and is set in type by a type-setting machine in the very act of arriving. Further, by the International Telegraph Congress it was settled that for all international telegrams only the Hughes instrument and the Morse were to be employed.

In 1875, Professor Hughes introduced the type-printer into Spain, where he was made a Commander of the Royal and Distinguished Order of Carlos III. In every country which it was taken to, the merits of the instrument were recognised, and Professor Hughes has none but pleasant souvenirs of his visits abroad.

During all these years, the inventor was not idle. He was constantly improving his invention; and in addition to that he had to act as an instructor wherever he went, and give courses of lectures explaining the principles and practice of his apparatus to the various *employés* into whose hands it was to be consigned.

What with this work, and his various journeys, Professor Hughes can have had little time for original work in other directions. But very soon after the type-printer was finally off his hands, his attention was drawn to the telephone. The researches of Sir William Thomson on the variation of electric resistance in a wire subject to stress, led him to enquire whether or not sonorous waves could not be made to vary the resistance of the wire itself of the telephone circuit by stressing it, and the result of his discovery was, as everyone knows, the microphone. The Hughes type-printer was a great mechanical invention, the greatest in telegraphic science, for every organ of it was new and had to be first fashioned out of chaos; an invention which stamped its author's name indelibly into the history of telegraphy, and procured for him a special fame; while the microphone is a discovery which places it on the roll of investigators, and at the same time brings it to the knowledge of the people. Two such achievements might well satisfy any scientific ambition. Professor Hughes has had a most successful career; and probably no inventor ever before received so many honours, or bore them with greater modesty.

THE SOURCE OF SOUND IN THE TELEPHONE.

AN EXPERIMENTAL INVESTIGATION BY AID OF THE MICROPHONE.

BY PROF. D. E. HUGHES.

A RECENT discussion upon the theory of the telephone* has caused me to make a series of experiments to determine if the sounds in that instrument were produced by the molecular action described by De la Rive, Page, Wertheim, and others, where sounds were heard in wires and electro-magnets upon the passage of a strong intermittent current through them; or if simple electro-magnetic attractions and repulsions were sufficient to fully account for all the phenomena of the telephone.

From a few experiments made some time since without any diaphragm and in which sounds and speech were perfectly reproduced, I was inclined to believe that we must look to the molecular action as playing a very important part, but on submitting each part of the telephone to experimental investigation by aid of the microphone, I have been led to believe that the molecular action is so feeble compared with the electro-magnetic attractions and repulsions, that its action has really no important *rôle* where we deal with such feeble currents as are generally produced in the telephone.

In order that the telephonic effects should be strongly marked and at the same time too weak to produce any molecular sounds, three elements of Daniell's battery were employed. These gave me telephone sounds sufficient to be heard at a distance of two or three feet, but at the same time, on submitting each part to the microphone so that it should take up only those sounds due to the organ submitted to its examination, no sounds were heard that could be fairly attributed to molecular action, whilst the effects due to known electro-magnetic action were extremely marked and distinct.

The microphones, which were vertical ones, were arranged in two distinct circuits, the first being used as a transmitter of undulatory currents to the telephone coil which was under investigation, the second microphone was attached to a small board 6 inches square and insulated by india-rubber feet, and wires were led from this microphone through a battery to a telephone; the batteries in each circuit was

* Comte du Moncel and Col. Navez. See TELEGRAPHIC JOURNAL, Sept. 1, 1878.

three Daniell's elements. The transmitting microphone was placed in a distant room and the source of sound generally used was an ordinary French *reveil* clock, this giving the maximum of sound obtainable without interruptions of circuit. In many cases the results were verified by transmitting speech; but I had long before found that whenever the peculiar timbre of the clock could be heard, articulate sounds were also perfectly reproduced.

By this arrangement, the microphone being so adjusted that it was only sensible to sounds mechanically transmitted to it through the board, whilst insensible to sonorous waves transmitted through the atmosphere, each organ of the telephone could be investigated separately by putting that piece alone in contact with the microphone table, whilst the other organs were held at certain distances in the air.

The following is a sketch of this arrangement :—

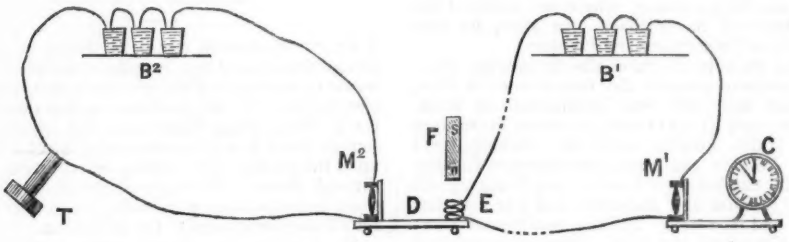


FIG. 1.

1st, or transmitting circuit :—C, clock, or source of sound; B^1, battery; E, coil, resting on sound microphone table; M^1, microphone transmitting electrical variations of current produced by clock C; F, natural magnet, held at certain distances but insulated by air from mechanical contact.

2nd, circuit upon which sounds produced upon the table were augmented by the microphone and transmitted to the receiving telephone; M^2, microphone; B^2, battery; T, receiving telephone, or microphone receiver.

This arrangement was used throughout the following microphonic experiments, and as we have now only to change the coil E, or affix to the table D any part under investigation, we shall in future refer only to the table D.

I will now speak of the experiments, which have all been reproduced several times at distant intervals, and on describing each, I will give the reasons for its result as they appear to me.

COILS.—Experiment I.—The ordinary coil of a telephone being placed on the table gave out no appreciable sounds. (I may here remark that, when I say no sounds, I merely state that with the feeble undulatory currents employed, no sounds were heard, although this same current was sufficient to produce exceedingly loud tones when all the organs of the telephone were put together and properly adjusted.) In the above case feeble sounds were heard if the battery was increased to twenty elements. Different coils of size, shape, and number of wire were tried, but no sounds were audible on any. On now approaching a strong bar magnet (6 × 1 inch) near to the coil, say ¼ inch distant, I at once hear the sound with all its peculiar timbre, the sounds increasing or decreasing as I put the magnet nearer or farther from the coil. The sounds, however, at their maximum, were but one-fortieth (approximately) of ordinary telephonic ones.

It is here evident that the sound is due to the mutual action between the current in the coil and the strong magnetic field, in other words to that electro-magnetic action which tends to cause a current in a wire crossing the lines of force in a magnetic field to move in a direction perpendicular to itself and to the lines of force which it crosses.

II.—A coil of fine iron (covered) wire (No. 30) gave out at first no sounds, but gradually became audible as the wire itself became magnetised by the current. If the bar magnet was brought near, the sounds were much louder than the copper coil, being about $\frac{1}{10}$ of telephonic ones. The magnetic field is here increased by the wire itself being a magnet.

III.—Two coils of copper wire of similar length but of different shape; the one being 2 inches in height by 1 inch diameter, the other a flat coil of 2 inches diameter by ½-inch; each being tried separately it was found when the pole of the magnet was held near their centres that the flat coil gave out double the sound of the other, but if held near the sides, the reverse effects took place.

(The larger surface of the flat coil explains the increased sound when a magnet is held over its centre, but in the second case the longer surface of the 2 inch helix explains its increased action.)

IV.—The coil resting upon table giving out clear sounds when the magnet was near, the magnet was replaced by the coil of an electro-magnet without its iron core. With a strong local battery passing through this coil similar effects to those of the magnet were obtained, though not so strong, owing to the difficulty of inducing so strong a magnetic field as the magnet alone; but on introducing its

iron core the sounds became as loud or louder in proportion to the strength of the field of force.

V.—If a flat magnet was laid on the table and the coil held at a distance, the sounds were louder and more metallic than in the cases when the coils were placed on the table. If the magnet was inside the coil and also resting on the table, the sounds were not nearly so loud as when the coil rested simply beside the magnet.

(In this case if the coil was absolutely fixed upon the magnet and no movement possible of the copper wire, we should only have the sounds due to the magnet and coil reacting upon the earth's magnetic field, and I found that if the coil was loose, much louder sounds were obtained than when it was fixed; but when it was placed flat on the side of magnet the full electro-magnetic reactions of coil on magnet were observed, consequently the sounds proved to be much louder than when the magnet was placed in the centre of the coil.)

VI.—If instead of the bar-magnet both poles of a horse-shoe magnet were introduced, the sounds were still heard, but far more marked when the coil lies on the sides of the horse-shoe. In this experiment the north and south pole, both being in the same coil, it would be natural to believe that one should neutralise the effect of the other, and I originally held this to be an argument in favour of the molecular theory; but we shall see in experiments under the head of "pendulum" that it is fully explained by the greater effect of the magnetic attractions than the repulsions.

VII.—If on one end of the bar magnet with its coil a microphone was attached so as to be influenced only by its elongation, no sounds whatever were heard—although it was sensitive to a hair lightly drawn across the pole. No trace of sound whatever could be heard; thus, if the sound was due to molecular changes, we should have certainly expected to have heard slight sounds at least from an undulatory current which was producing sufficient electro-magnetic changes to give out the loud tones upon the diaphragm, as already mentioned.

VIII.—If upon the microphone table I strained a wire 6 inches long, similar to a musical string, and through this wire pass the current, I heard no sounds; but on putting a strong horse-shoe magnet so that the wire was between the poles (which in this case should not be apart more than $\frac{1}{2}$ inch), I heard very plainly, and remarkably so, when we consider that in the case above mentioned, there were but a few inches of the wire under the influence of the magnetic field. Sounds were thus obtained from a wire only one centimetre long on the board; fine iron wire gave out the loudest effect, but this was found to be due simply to its becoming magnetised and thus reacting more strongly on the field of force.

(In all the above experiments the sound obtained was not at its maximum more than one-twentieth of telephonic ones, so we cannot consider any of these points as predominant sources of sound.)

IX.—ARMATURES OR DIAPHRAGMS.—An iron armature, no matter what form or size, when placed upon the microphone table gives out loud tones, the magnet and coil being held in the air and thus insulated; the loud tones can only be due to the armature in contact with the table.

(The sounds here are due to magnetic attractions, the loudness depending upon the best conditions for movement and rapid action in a strong magnetic field. In some following experiments this point will be elucidated.)

X.—If a copper coil without the magnet, is held above these armatures, the sound is comparatively weak. An iron coil gives louder tones, due to its becoming magnetised, but both are very weak compared with those given by the side of the natural magnet. An electro magnet with iron cores was not equal to the natural magnet, because the battery was too weak to induce a high magnetic field.

XI.—With different metals and non-conductors, such as wood, glass, gutta-percha, ivory, metallic oxides, &c., &c., it was found that all conductors, if sonorous, gave out sound; but no continued trace could be found with mercury, and but slight traces with lead. All the non-conductors gave no sound whatever.

Compared with iron the following is an approximate value, being the mean of several repeated experiments :—

Iron	100
Silver	10
Copper	9
Bronze	9
Zinc	8
Gold	8
Brass	7
Cadmium...	6
Tin	4
Lead	2
Carbon	2
Mercury	1
Wood, Glass, and all non-conductors	0

(All the above non-magnetic conductors gave out sound by direct mechanical movement, caused by the induced currents re-acting upon the magnetic field, giving repulsions where iron was attracted. This will be shown in some following experiments.)

XII.—With all the non-magnetic metals, the sound was loudest if the armature had a large surface, as a plate or sheet; the sounds were at their maximum when the magnet and coil were held over the centre of the plate, and gradually diminished when moved towards the edges.

(This shows the importance of the diaphragm form of armature, and in the case of copper, the induced currents had a wider field for action when the magnet was held at the centre than when at its edges.)

XIII.—Each metal gave out its own particular timbre, which could be perfectly reproduced by touching it with a small strip of thin paper at the point where the centre of the magnet had been held.

(This shows that the supposed molecular sounds were really mechanical movements which could be reproduced by a feeble mechanical effort.)

XIV.—A coil of insulated copper wire placed on the table as an armature, gave but feeble traces of sound if the two ends of the wires were insulated, but on joining the wire or short circuiting the coils, loud and distinct tones were always obtained.

(This proves that the sounds are due to the re-action of induced currents in the coil upon the magnetic field.)

XV.—A coil of uncovered copper wire gave out sounds if the ends were open or closed, being then similar to a copper plate, where the currents can flow in closed circuits.

XVI.—A flat magnet gives out louder tones than an iron armature of the same form, and a still more remarkable difference is observed if a coil alone without its magnet is held above. In this case, the magnetic armature gives out tones ten times stronger than the simple iron, thus showing again the necessity for a strong magnetic field of action.

XVII.—A coil of covered iron wire gives out the same amount of sound whether the circuit be closed or open.

XVIII.—A thin iron plate armature gave out loud and clear tones; these tones were but slightly diminished by the interposition of another thin plate or plates, of iron, between the magnet and coil and armature. Sounds were thus obtained through fifteen interposed iron diaphragms, being then but a quarter of the original sound. If, however, the sum total of all the diaphragms could have been utilised, the total sound would have been greatly augmented.

XIX.—The coil of covered copper wire was laid on the top of a ferrotype iron plate; the natural magnet alone held above this, gave out strong tones, but if the coil was placed underneath the ferrotype, the sounds were but one-third of its previous force; this shows the advantage of having the coil direct in the magnetic field, between the magnet and its armature. In both cases, sounds were scarcely audible when the natural magnet was withdrawn: they were not one-twentieth of the original sound intensity.

(From this we cannot expect any perfect electromagnetic telephonic arrangement which does not employ a strong magnetic field for its reactions.)

XX.—If we place on the microphone table a solid cube of iron (2 inch cube), the coil and magnet being held at a slight distance, we hear distinctly the tones, but far more feeble than in the case of a thin ferrotype of the same diameter. With the ferrotype we hear a clear metallic ring with each tone, but with the cube of iron there was no such ring, the tone being dull and muffled; in fact, the tones were those of the microphone table itself, thus indicating that the slight mechanical movement of the iron cube was transmitted to the wood, which, by it elasticity, became in reality the diaphragm or source of sound. To prove this, we found that sounds increased up to the moment when the natural magnet touched the iron, when they attained their maximum. On pressing the magnet on the iron with gradually increasing pressure, the sounds gradually faded until but slight traces were audible. On removing the pressure, sounds increased until the magnet raised the iron slightly: here was the maximum; but the instant the iron by its own weight broke the contact and thus again pressed more heavily on table, the sounds almost disappeared. Compared with the ferrotype, it was found that the latter gave out louder tones with the magnet and coil held at 3 inches distance, than upon the cube of iron at $\frac{1}{10}$ inch distance. At $\frac{1}{4}$ inch distance but feeble traces of sound could be heard in the cube, whilst the ferrotype gave out loud tones with its own peculiar metallic ring. In both cases the peculiar timbre of the cube and the ferrotype could be reproduced by touching it lightly with a thin strip of paper; thus, a slight mechanical movement would easily account for the sounds in both cases.

XXI.—A ferrotype diaphragm laid loosely on microphone table. Magnet and coil held above gave out with each sound a metallic ring exactly the same as when the same diaphragm was held to the ear and slightly touched by a piece of paper. If it was fastened on the table by its circumference, as in the telephone, we had one dominant musical note with each sound. If fastened only at its centre, the metallic ring would be prolonged long after electromagnetic sounds had ceased, it being then in a constant state of vibration from the slightest extraneous cause. If we glued or fastened this diaphragm to a thin cardboard, the metallic ring disappeared, and the tone became slightly weaker and muffled. If the diaphragm was glued throughout its surface to a similar piece of pine board 1 inch thick, the tones became very weak, resembling the cube of iron, and the tone was no longer that of iron, but that of wood.

(This shows that the tones could not be due to any particular molecular movement in the iron plate, but that the tone or timbre is due to the body actually in movement, as the metallic tones of iron can be gradually masked, partaking of the intermediate tones of iron and wood, until, by increasing the thickness of wood, the metallic tones are entirely lost by the predominance of those of the wood.)

XXII.—The surface of a diaphragm of cardboard had glued to it parallel layers of thin uncovered iron wire; this diaphragm gave out the tones of cardboard either on the microphone table or if it replaced the ferrotype in an actual telephone; in both cases the tone was comparatively weak, compared with the same amount of iron and surface in the ferrotype, a result due to the want of elasticity in the cardboard. The same iron wire glued to a thin glass plate gave out clear, sharp tones, but the tone was that of glass, and not that of iron. From this we should judge that the varnish on ferrotype serves an excellent purpose in slightly muffling the metallic ring of the iron plate.

XXIII.—In order to see if we could render these movements of the diaphragm visible to the eye or touch, a thick tin plate diaphragm was placed in a telephone in direct circuit of the first transmitting microphonic circuit. The sounds were very clear and loud, but no movement whatever of the diaphragm could be perceived by the eye or touch. A very thin charcoal iron plate was now used; the tones were louder than before, but still no visible movement. This plate then had a small narrow segment cut out of it from the circumference to the centre.

The sound was slightly diminished, but strong movements were visible both to eye and touch; by placing the finger on the divided portion not only could every beat of the clock be perfectly felt, but its peculiar timbre in a slight degree recognised.

(Here we have transformed a sound which in the first place gave out no visible movement, and which might from this be supposed to be due to some molecular motions, into one of direct mechanical movement recognisable by touch, and where molecular action is not at all necessary to its explanation.)

XXIV.—Knowing that each diaphragm in a telephone has its own dominant tone, which accompanies all sounds emitted, the diaphragm was divided into two slightly unequal portions. Clear loud tones were then produced as before, but they were accompanied with two dominant tones—in fact, a chord, due to the different dominant tones of each segment of diaphragm. By chance they happened to be an exact fifth, and the word "telephone," like all other words transmitted to it, was accompanied by the dominant chord, thus :

and I am convinced that by proper arrangements four segments reproducing the whole cord could have been obtained, thus :

(To be continued.)

THE WERDERMANN ELECTRIC LIGHT.

THE most recent development of the electric lighting system is that invented by Mr. Richard Werdermann, and which was shown on Saturday, November 2nd, at the works of the British Telegraph Manufactory, 374, Euston Road, to a number of scientific gentlemen and representatives of the press.

Mr. Werdermann was assisted in his experiments by Mr. Berger Spence and Dr. Cornelius Herz. The chief object of the inventor was to demonstrate that by the new system a considerable number of lights could be placed in one circuit and steadily maintained without the employment of any clockwork or electro-magnetic apparatus connected to the lamps.

The display was chiefly of an experimental character, the lamps used being somewhat different in construction to those which will be placed in actual work, but it was quite sufficient for scientific purposes.

The principle of Mr. Werdermann's invention, consists in keeping a small vertical pencil of carbon in contact with a large horizontal disc of the same material above it. Mr. Werdermann was led to adopt this arrangement as the result of numerous experiments.

Referring to fig. 1, which shows the ordinary arrangement of carbons in an electric lamp, it is well known that when the passage of the current is such that the top carbon is a positive pole, the end of this carbon becomes cup-shaped, whilst the end of the other carbon becomes pointed, by the action of the current. By increasing the lower carbon considerably in sectional area, Mr. Werdermann found that, with the same amount of current passing, it was necessary in order to maintain the continuity of the arc, to place the two carbons closer together ; he also noticed (as a curious fact) that a little cylindrical pimple of carbon was formed in the middle of the lower carbon electrode, as shown by the figure ; also the end of the upper carbon tended to spread out. On still further increasing the size of the lower electrode, it was found necessary to bring the two carbons still closer together in order to maintain the continuity of the arc ; the little cylindrical pimple then became much smaller in size, and the end of the upper carbon spread out still more. If now, the lower carbon was still further enlarged, so that it had a sectional area sixty-four times as large as that of the upper carbon, it was found that the continuity of the circuit could only be maintained by keeping the two carbons in actual contact ; and further, it was observed, that the end of the upper carbon, which had previously tended to spread out, now took a pointed form. When actual contact took place the little pimple of carbon disappeared, and a brilliant light was given out by the incandescent point.

Figs. 5, 6, and 7 show what occurred when the larger carbon formed the positive pole. Under these conditions the end of the small electrode became heated to a red heat only, whilst a small portion only of the large electrode became heated to a white heat by the passage of the current ; this was also the case when the upper electrode was increased in size, and the two carbons had to be approached closer together in order to maintain the arc. When, however, the upper carbon was increased to such a size that continuity could only be maintained by actual contact, then a curious change took place : the upper carbon no longer glowed, but the point of the smaller carbon, previously only red-hot, now became white-hot, and assumed the conditions shown by fig. 4. The light given out when the larger carbon formed the positive pole was found to be not quite so great as when it formed the negative pole. The heat being almost entirely confined to the smaller carbon, the larger one was not consumed to any appreciable extent.

During the whole time that the smaller carbon burns, it retains its pointed form, and a small electric arc is plainly visible round the points of contact of the two carbons. The greater part of the light given out is produced by this small arc.

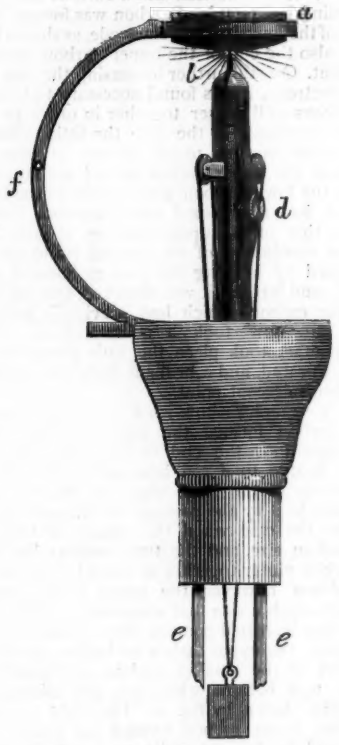
In accordance with the foregoing results Mr. Werdermann constructs his lamps in the following manner :—

He places the negative electrode uppermost, giving it the form of a solid disc of carbon, about two inches in diameter and one inch thick. This is encircled by a band of copper ribbon and prolonged to a terminal to which one of the machine wires is attached. The lower or positive carbon, which is a

thin round pencil, 3 millimetres in diameter, is placed vertically beneath the negative electrode, in a tube up which it slides. This tube has a prolongation of thick copper divided in two parts, and pressing against the pencil and forming contact with it, this forms the other terminal of the lamp.

The lower carbon is kept in contact with the upper one by chains attached to its lower extremity, coming up over pulleys and down again to a counterbalance weight, which always keeps the point of the pencil in gentle contact with the disc as the former gradually burns away.

FIG. 1A.



By referring to the sketch, fig. 1A, the general idea of the lamp will be seen at a glance.

"*a*" is the negative carbon, *b* is the pencil sliding in the tube *c*, and gripped at the top of the tube by the split contact piece, the pressure of which is regulated by the spring *d*. The conductors *e* form part of the lamp post, having terminals at the bottom, and one is connected to the tube, the other, by means of the semicircular piece of metal *f*, to the upper carbon; *f* is hinged for the purpose of moving away the negative disc when a globe is to be put on the lamp.

The tube is shown in perspective for the sake of greater clearness.

The experiments were commenced by putting two tall lamps in circuit such as will be used for out-door lighting.

These lamps gave a light estimated at 360 candles each, and were connected together in parallel circuit. The lamps had no globes, and the lights were wonderfully clear, of a pure colour, and perfectly free from the blue or purple rays so often seen in the electric arc. Better than all was the remarkable steadiness of burning, there being an entire absence of any jumping or flickering whatever.

After allowing these to burn for some time, the current was then sent through a row of 10 smaller lamps, arranged on a shelf, and connected parallel. These lamps were estimated to give about 40 candles each, each one burned with the same brilliancy and steadiness, and proved most conclusively that the divisibility of the light was an accomplished fact, and when we say that this satisfactory result was obtained with an electro-plating Gramme, the bobbins of which are wound with thick copper ribbon, and giving an electro-motive force of only 4 Daniell's cells, it seems probable and reasonable to suppose that with suitable machines, Mr. Werdermann will be enabled to put 50, 100, or even 500 lights in circuit, and thus solve the problem of dividing the light more completely than has hitherto been the case.

In fact, Mr. Werdermann stated that had his lamps been ready he could have put in circuit a considerably greater number of lights than were exhibited.

Fig. 2A shows the connections of the 10 lamps.

The thick wires + and — are the cables connecting the lamps with the Gramme machine, the first lamp on the pos. being the last on the neg. The spirals "*a*" are equal resistances placed in the circuit of each lamp for the purpose of rendering any variation in the contact or pressure of the two carbons less appreciable to the passage of the divided currents.

The resistance on the average of each small lamp including the extra resistance "*a*" is 0·392 ohms.

5 lights parallel ... „ 0·076 ohms.
10 lights, do., as exhibited „ 0·037 ohms.

The resistance of the large lamps is rather less than that of the small ones.

In the 10 small lamps the carbon pencils burn away at the rate of about 2 inches per hour.

The large lamps having pencils of 4½ mm. diameter, burn from 2½ to 3 in. per hour.

The carbons are manufactured in Paris in lengths of about one yard, and at a cost of about 1 franc per yard, which length would keep up a light for 12 hours.

The negative discs are of ordinary battery carbon, and the weight required to keep carbons in contact is about 1½ lbs.

The length of carbon protruding from the tube and made incandescent is ¾ of an inch, but this length can be varied at pleasure. However many lights may be put in circuit the extinction of one or more will not affect the rest, a switch arrangement attached to each lamp effecting all that is required for the regulation of the current.

Then again, by this system, all the lamps are lighted simultaneously, and can all be as readily extinguished, and again re-lighted.

In regard to the strength of this light, we have before observed that one object of the inventor is to moderate the intensity, so as to avoid having any of the illuminating power reduced by covering the

lamps with opal or ground glass globes, as in other systems. The two large lamps did not dazzle the eyes, there being no change of colour and no jumping, so it is therefore the intention of Mr. Werdermann to use ordinary glass globes, so that scarcely any loss of light will be incurred.

To some questions put to him by a gas engineer, Mr. Werdermann aptly compared the quantity of current with the quantity of a gas-holder, and the electro-motive force of the current to the pressure of gas.

For instance, if a gas-holder held sufficient gas, and had enough pressure to supply 100 burners, it would be necessary to increase the quantity and pressure of the gas to equally light 200 jets. It is the same with the electric light. If with one machine of given quantity and electro-motive force, 100 lights can be produced, then if 200 lights are required we must have a machine with a greater quantity of current (corresponding to the capacity of the gas-holder), and with greater electro-motive force to carry the lights further away (answering to the pressure of gas).

It may be mentioned that Mr. Werdermann does not believe in the divisibility of the current *ad infinitum*, as claimed by Mr. Edison, but that for practical purposes he has every confidence that the system we have described will solve the problem of general electric lighting, and that he will be able to carry the current to a considerable distance. Mr. Werdermann has already had numerous applications for the installation of his system.

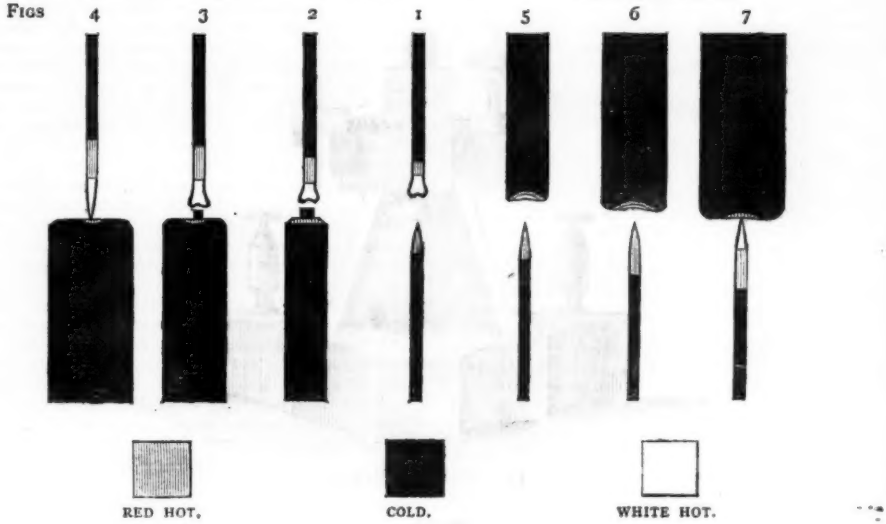


FIG. 2A.

In conclusion we give some details of the machine by which the lights were produced. It is of the old form of Gramme electro-plating machine, with four upright electro-magnets, and two bobbins revolving between them. The bobbins are iron rings wound each with 48 sections of copper ribbon seven-sixteenths of an inch wide, and one-tenth of an inch thick. Each section has three convolutions. One bobbin is used for magnetising, or feeding the electro-magnets, the other for producing the working current. The resistance of this latter bobbin is about 0·008 ohms, and the electro-motive force, as before mentioned, is only four Daniell's cells, the machine being driven at a rate of about 800 revo-

lutions per minute. The quantity of current produced is of course large; but as the intensity is very low, it follows that the insulation of the conducting cables could easily and cheaply be provided for.

The heating of the machine after several hours continuous running was but very slight.

The power required to drive the machine is only two horse-power.

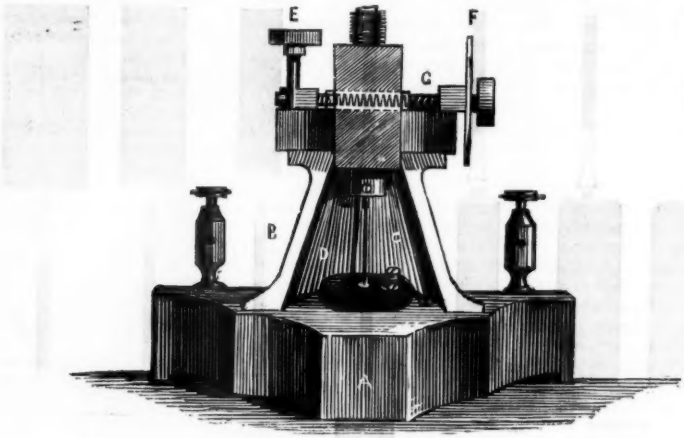


FIG. 1.—FRONT REMOVED.

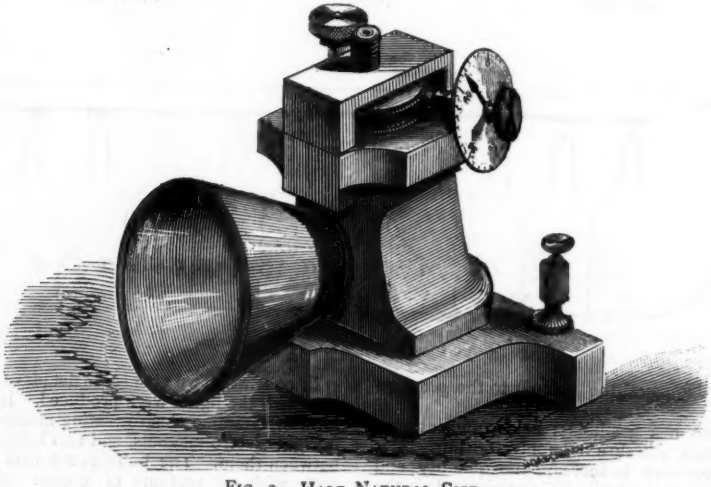


FIG. 2.—HALF NATURAL SIZE.

EDISON'S NEW MICRO-TASIMETER.

By W. F. BARRETT.

IN its present form the instrument differs considerably from that described in the TELEGRAPHIC JOURNAL of August 1st, although the essential parts are the same. The object of this modified arrangement is to insure greater sensibility and protection from accidental sources of disturbance. Sketches of the instrument are here given. The carbon button is laid flat within an insulating cup in the centre of a small but massive brass base A; resting on the button is a light metal disc which supports a slender strip of vulcanite, about an inch long and a quarter of an inch wide. Vulcanite is used on account of the comparatively large dilatation it undergoes when warmed, but a strip of blackened zinc is more prompt in its indications. The upper end of the vulcanite strip abuts against the base of a vertical screw, capable of an extremely fine motion by means of a worm-head gearing into a tangent screw G. Attached to the milled head of the latter is a small pointer moving over a graduated circle F

Each division in this circle corresponds to a motion of the fifty-thousandth part of an inch imparted to the vulcanite strip, and thus a corresponding small degree of pressure can be brought to bear upon the carbon button below the strip. A polished cone converges radiation upon the vulcanite, which is enclosed in a metal casing except on the side opening to the cone. The upper and lower faces of the carbon button are in metallic communication with a cell or two of a constant voltaic battery and with a delicate reflecting galvanometer of low resistance. A Wheatstone's bridge and resistance coils are also included in the circuit to balance the resistance of the carbon; and at first a "shunt" of thick wire is necessary to deviate through itself the greater part of the current, and so curb the motions of the galvanometer needle. When the proper balance is obtained—the fine adjustment being made by turning the micrometer screw that presses the carbon—the shunt is removed and the tasimeter is ready for a test experiment.

The heat radiated from one finger held near the cone is more than sufficient to drive the galvanometer index right across and off the scale. In a letter relating to this tasimeter, Mr. Edison writes to me as follows:—"By holding a lighted cigar several feet away I have thrown the light right off the scale," and by increasing the delicacy of the galvanometer, "the tasimeter may be made so sensitive that the heat from your body, while standing 8 ft. from and in a line with the cone, will throw the light off the scale, and the radiation from a gas jet 100 ft. away gives a sensible deflection."

These statements—less extravagant than those that have appeared in some newspaper reports—are quite consistent with my experience of the instrument, and they show that the tasimeter is a marvellously delicate thermoscope, and as such, or as a means of detecting minute variations in pressure, it is a really valuable addition to the cabinet of the physicist. It is not, however, likely to displace the thermo-electric pile in experiments on radiant heat; albeit, when the small area on which the radiation falls in the tasimeter is taken into account, it is no doubt a more delicate thermoscope. In fine, owing to the narrow linear surface it exposes, the tasimeter will probably do good service in such researches as the distribution of heat in solar and other spectra, and in exploring the ultra-red portion of the solar spectrum. By an ingenious device, characteristic of the man, Mr. Edison has shown how the tasimeter may be used as an instrument for detecting the presence of moisture in the atmosphere. All that is necessary is to remove the vulcanite strip and replace it by a strip of gelatine varnished on the unexposed side, when it becomes an hygrometer of surpassing delicacy. Another application of the tasimeter, which, perhaps, Mr. Edison will allow me to suggest, is for detecting variations in the pressure of the atmosphere. As a new form of aneroid baroscope it would doubtless give extremely prompt and delicate indications, and thus be of considerable service to meteorologists. The application of the instrument for detecting minute changes in the length of a body is obvious, but before it can come into use in any quantitative experiments, further investigation is necessary, and several minor modifications of the present apparatus are requisite.

Notes.

THE TELEPHONE.—Mr. McLure, the manager of the Bell Telephone Company, London, has effected several convenient improvements in the Bell telephone and its fittings. To adapt the telephone for general household use Mr. McLure arranges an alarm bell, indicator, and commutator in the servants' hall, and a telephone in each room. When a person in one of the rooms wishes to communicate with the attendant he simply touches a spring in the stem of the telephone at his disposal: this rings the alarm bell and indicates the room from which the call has come to the attendant. The attendant, by setting the commutator to that room, re-sets the indicator to its zero position and puts his telephone in circuit with that in the room in question. Conversation can then be carried on between them. By this arrangement telephones can be supplied to every room in a house at as cheap a rate as electric bells, thus effecting a considerable saving of time and trouble. By a similar arrangement persons in different parts of a city can converse through the medium of a central station, in which the commutator is placed. Mr. McLure, among others, is now experimenting with a view to overcoming the induction clamour on telephone lines.

THE MICROPHONE.—On another page we publish an important investigation by Professor Hughes into the sources of sound in the telephone—a problem which has been rendered soluble by means of the microphone. The research in question is the continuation of some former experiments recorded in the *Telegraphic Journal* for September 1. Some of the facts demonstrated cannot fail to be useful in the improvement of telephones.

THE PHONOGRAPH.—The Stereoscopic Company are not yet prepared to supply phonographs to purchasers. The price to be put on them when they are offered for sale is, we believe, thirty guineas.

THE ELECTRIC LIGHT.—The details of Edison's new invention are still kept secret, and, as will be seen from our list, a second patent has been applied for. Meanwhile, the *Scientific American* professes to give the following partial information, which is a little more explicit than what was vouchsafed to us in our last issue:—"The Edison light," says our contemporary, "is based on the well known fact that a wire may be heated by an electric current, the basis of many attempts to accomplish what Mr. Edison claims to have done. The reader may have seen the gas jets of the dome of the Capitol at Washington, lighted by similar means. Over each burner is placed a coil of platinum wire, which, when heated by the electric current, ignites the gas. Mr. Edison uses the coil itself as the source of light, the current sent through it being strong enough to make the coil white hot, or self luminous. The difficulty to be overcome at this point was the liability of the wire to fuse and spoil the light; a difficulty which Mr. Edison claims to have obviated by the introduction of a simple device which, by the expansion of a small bar the instant the heat of the coil approaches the fusing point of platinum, interposes a check to the flow of the current through the coil. This automatic arrangement, in connection with an auxiliary resistance coil, secures, it is said, an even flow of electricity through the coil, and consequently a steady glow of pure light. If this is done economically it is obvious that a marked advance has been made in artificial illumination." It may be presumed that Mr. Edison

has more to reveal than what is given above, for although this device will undoubtedly facilitate the subdivision of the current for lighting purposes, it will not alone justify the inventor's claim.

A COMMISSION has been appointed to examine the question of illuminating the harbour of Cronstadt by the electric light, in order to prevent night attacks on the forts.

A MUNICIPAL council is also considering the advisability of lighting the streets of St. Petersburg by electricity.

ON Monday, November 4, a football match was played at Kennington Oval by Siemens' electric light, but it was only a partial success by reason of the operators not being able to direct the beam quickly enough upon the ball.

ARNAUD'S ELECTRIC LIGHT DIVIDER.—M. Arnaud explains that his system consists in inserting cross circuits between the outgoing and returning wires of the main circuit. These cross circuits contain the lamps, and a specially divided current, giving equal lights to all the lamps, is sent into this complete circuit.

THE electric light is being tested for use in the Royal Arsenal workshops and at the Woolwich laboratories. It will also be tried in the General Post Office, St. Martin's-le-Grand.

THE *American Journal of Gas Lighting* now triumphantly asks, How is the electric light to be measured and sold? Gas can be estimated both in quality and quantity; but electricity!—that is a very different affair. In another part of the same journal a second fatal objection is put forth—"the ladies dislike it." Can human gallantry resist this appeal?

EXTENSIVE additions begun at the Beckton Gas Works have been stopped pending the invasion of the electric light.

THE electric light is likely to reduce the price of coals considerably, since the gas companies will consume a greatly reduced quantity.

RAPIEFF'S ELECTRIC LIGHT.—M. Rapieff has further improved his electric light which we illustrated and described in our last issue, by substituting a single thick carbon for the two upper rods. This improvement would seem to approximate the light somewhat more to Werdermann's plan.

THE pre-announced trial of Jablochkoff's candle at Billingsgate Fish Market on Nov. 5, did not come off, but preparations are now being made for one on an early date. There will be sixteen 1,000 candle-lights reduced 60 per cent. by opal globes. Eight of these will illuminate the ground floor, an area of nearly 40,000 square feet. The whole building will be illuminated inside as well as the outside front.

REYNIER'S ELECTRIC LIGHT.—One of the successful competitors for electric light renown is E. Emile Reynier, a young Parisian student of science and electric mechanician. Reynier's lamp consists in a slender upright stick of carbon placed so that its point is tangential to the edge of a thick disc of carbon. The stick is fed by the positive current, and the disc by the negative, and as the point is in contact with the disc there is no voltaic arc to speak of, but merely incandescence of the carbon stick, which slowly burns away. To the disc is given a slow rotation and the ash of the carbon stick is thus cleared away. As the stick consumes it is forced downwards into contact with the edge of the disc by the descent of a heavy bar. From this description it will be seen that Reynier's *lampe electrique à incandescence*, as it is called, is somewhat similar to Mr. Werdermann's which we illustrate on another page; but it is clearly not the same. Werdermann's is a *lampe à incandescence;* but by a different arrangement of the carbons, he produces a finer and steadier light than Reynier, by means much simpler. Reynier's lamps are made by the Société des Lampes Electrique Frangaise, 71, Rue de la Victoire, Paris. Price £5.

IT is said that a householder, whose gas had been suddenly cut off recently, brought matters right by sending a photograph of Edison to the gas company.

THE New York Board of Aldermen, on the 14th ult., granted permission to General Spinola to introduce the Holly Steam Heating system into that city. This system consists in distributing steam from central stations to streets and houses by means of pipes for heating purposes. Should the New York gas mains be rendered by Edison's invention no longer useful for gas they may do for the steam.

WHEN Edison brings that new electric light into use, the fellow who goes to a party with a patch on the knee of his pants must come out of that dark corner and be exposed.—*Detroit Free Press*, U.S.

THREE applications of the electric light are obviously practicable forthwith, and likely to be of great service, namely, lighting ships at sea, lighting railway trains, and lighting fields, so that harvest operations can be carried on at night during the spells of good weather which the farmer finds so rare in these isles.

THE Nez Percé Indians of Fort Leavenworth, on the Missouri, have a system of flash-signalling by mirrors, which resembles the Morse code, but has not yet been interpreted by the white man.

TOMMASI'S RELAY.—We print on another page a report of the Anglo-American Telegraph Company's superintendent at Brest on the recent trial of this relay on the French Atlantic Cable. We saw this relay at the Paris Exhibition, where M. Tommasi exhibited to all comers its transcendant merits as a receiver on long submarine cables, by showing how many degrees it would deflect under a current sent through a block of dry wood. If M. Tommasi wishes to perfect his instrument for submarine signalling we would recommend him to adopt an artificial line of a nature somewhat less primitive than a plank.

A SEVERE snowstorm on the 4th of this month played great havoc among the Austrian telegraph lines for nearly a hundred miles round Vienna, and telegrams had to be forwarded by rail. The snow lay a metre deep, and all traffic was suspended.

NEW ZEALAND has now consented to join with Victoria, New South Wales, and South Australia in procuring a duplicate line of telegraph with England. At the meeting of the Eastern Extension Telegraph Company on November 6, it was stated that the carrying out of this work was temporarily postponed owing to the parliament of New South Wales having caused some alterations to be made in the agreement.

THE Continental Telegraph Company, United States, has opened for business with six offices in New York, six in Philadelphia, and one in Trenton, New Jersey. The company will soon have four wires to Philadelphia, and wires to Baltimore, Washington, and Boston will soon be erected. There is already a brisk rivalry between it and the Western Union Company.

THE WESTERN UNION TELEGRAPH COMPANY.—At the commencement of the fiscal year 1867, the Company operated 46,270 miles of line, 85,291 miles of wire, and had 2,565 offices. The capital and bonded debt amounted to 46,275,410 dollars. Thus each mile of wire was represented by 541.98 dollars of capital and debt. On the 30th of June, 1878, the miles of line had increased to 81,002, the miles of wire to 206,202, and the number of offices to 8,014. This was represented by a capital and debt (deducting the amount of the former owned by the Company) of 41,248,576.64 dollars, which averages within a fraction of 200.03 dollars per mile of wire. In addition to the property above enumerated, the company owns in stocks of other companies ,real estate, &c., over 8,000,000 dollars, which being deducted from the gross amount of capital and debt, the net average is about 160 dollars per mile. The number of messages transmitted has increased from 6,404,575 in 1868, to 33,918,894 in 1878. The number of messages annually transmitted per mile of wire has increased from 66 in 1868, to 116 in 1878. There has been a constant and rapid decrease in the average tolls per message from 104.7 cents in 1868, to 38.9 cents in 1878. The average cost of transmission has decreased in ten years from 63.4 cents to 25 cents per message, and the average profit from 41.3 to 13.9 cents. The decrease in the average tolls for the last year, notwithstanding the absence of competition and the increase of some competitive rates which had been reduced below the actual cost of doing the business was 4.7 cents. The further reduction of tolls without reducing the average profit per message will, it is believed, be warranted by the economies introduced into the expenditures which are now fairly inaugurated.—*Journal of the Telegraph*, U.S.

NICKEL-PLATING.—WE have received a small pamphlet on "Nickel-plating: its History and Useful Applications," from Mr. W. Elmore, 41, Queen Victoria Street. The process of nickel-plating dates as far back as 1843, it appears, when it was introduced by Professor Boettger. Boettger employed the double sulphates of nickel and ammonia, and the double chlorides of nickel ammonium, salts which are still found the best for the purpose. The Americans have recently improved greatly on the manufacture of these salts, and the refining of nickel. They have also applied the dynamo-electric machines instead of the voltaic battery to the electro depositing process; and we are told that there now over two hundred nickel-platers in New York alone. There are also many in France, Belgium, and other European countries. The advantages of dynamo-electricity for electro-typing will be seen when it is considered that a fine clear deposit or "shell" of copper 800 square feet in area, can be obtained from a dynamo-machine in less than three hours, without pin-hole, or other defects common to battery deposits. Mr. W. Elmore has introduced these American improvements into England, and is now carrying on the process of nickel-plating among us. He employs the Weston dynamo-electric machine, described in the TELEGRAPHIC JOURNAL for April 15, 1878, and is agent for it in this country.

A GREAT number of the rural communes of France who complained a short time ago of the excessive tax to be imposed on them for telegraphic weather reports have agreed to pay a reduced tax.

A PARIS Exhibition gold medal was awarded to Sir William Thomson for his patent compass.

THE Faraday lecture was delivered at the theatre of the Royal Institution on Tuesday, November 12th, by Prof. Ad. Wurtz.

AT the first meeting of the Society of Telegraph Engineers for the coming session on November 13th, Mr. Andrew Jamieson, C.E., hon. sec. of the Society for Malta and the Mediterranean, read a comprehensive and instructive paper on "Cable Grappling and Cable Lifting." A full account of the paper will be given in our next.

ELECTRIC RESISTANCE OF WATER AT DIFFERENT TEMPERATURES.—MM. Exner and Goldschmidt find that the resistance of pure water uniformly decreases as the temperature rises, the resistance at 99° being about a third of what it is at 20°. A similar result was obtained with water acidulated with sulphuric acid.

THE AURORA BOREALIS.—Prof. Edlund, of the Swedish Royal Academy, in a series of papers now being published in the *Phil Mag*, deduces the theorem that all other circumstances being equal, the resistance to the flow of the electric fluid from the atmosphere to the surface of the earth is greater at the equator and in the equatorial regions than at a certain distance from that circle, and that the resistance diminishes as the dip of the magnetic needle to the earth increases. And in this he discovers the cause not only of the strong disruptive discharges of violent tropic thunderstorms, but the rarer and gentler discharges of higher latitudes, culminating in the aurora borealis, in which the discharges are transformed into slow and continuous currents.

INFLUENCE OF ELECTRICITY ON VEGETATION.—M. Celi is conducting experiments on this interesting subject similar to those of M. Grandeau to which we recently alluded. This mode of operation consists in growing two similar seedlings in equal quantities of the same soil, water and air; the only difference between their conditions of growth being that one of them is grown in a specially electrified atmosphere. The apparatus consists of a water-dropping collector, that is, an insulated metal basin of water from which a fine jet is constantly flowing and breaking in spray. This basin consequently takes the potential of the surrounding atmosphere, positive ordinarily, but sometimes negative in broken weather. The plant to be electrified is enclosed in a bell jar, and a wire runs from the basin to a set of metal points within the bell jar which give off electricity to the air let into the jar. The non-electrified plant is also enclosed in a similar bell jar and the same quantity of air is let in, but there is no special arrangement for electrification. On July 30 last, three grains of maize of equal weight were sown under each of these bell jars. On August 1 they sprouted, and for two days kept pace with each other in their growth; but on the third day the electrified plants began to develope more rapidly than the others, and on August 10 the relative heights of the plants were 17 and 8 centimetres.

DETERMINATION OF MAGNETIC MOMENTS IN ABSOLUTE MEASURE.—In his experiments on the intensity of the earth's magnetism in absolute measure, Gauss determined the magnetic moment of the steel magnet

he employed to be 22·2 per gramme mass in C. G. S. units; and calculated that the mass of steel which would have to be placed in each cubic metre of non-magnetic matter in order to make up a globe of the same magnetic moment as the earth would be 3·55 kilogrammes of the same kind from which his magnet was made. Mr. Thomas Gray, B.Sc., now demonstrator in Physics, and Instructor in Telegraphy in the Imperial Engineering College of Tokio, Japan, but formerly a student of Glasgow University where the experiments were made, has been investigating the magnetic moments of similar bars differently tempered. His results are given in the *Phil Mag* for November. Mr. Gray finds that the magnetic moments of blue-tempered soft steel magnets are greater than those of glass-hard soft steel magnets for the same magnetising force, and that the difference between them diminishes as the magnetising force is increased. Magnets made of steel which had been heated to redness and then cooled in oil had comparatively small magnetic moments when cooled in cold oil; but the magnetic moments gradually increased as the temperature of the oil was raised till it reached about 150° C., after which the magnetic moments were smaller the higher the temperature of the oil. The magnetic moments of these bars varied from 60 to 80 per gramme. Magnets made of steel which had been prviously heated to a bright red and suddenly cooled in water were scarcely so strong, after first magnetisation, as those of the same seeel which were after the same treatment again heated in oil to any temperature up to 310° C., and afterwards allowed to cool slowly in air. Experiments on magnets tempered from homogeneous iron wire supplied by Messrs. Webster & Horsfall for the 1865 cable gave results at variance with the above. Thus for glass-hard tempering the magnetic moment per gramme was only 20·22; for yellow tempering 17·18; for blue 11·29, and in the state as supplied 12·09. Mr. Gray found that the magnetic moments of these magnets were found to change very little, if at all, by lying nine months undisturbed, though on being allowed to fall they lost a slight percentage of force.

CONTACT ELECTRICITY.—Mr. J. Brown finds that with a dry couple formed of a plate of iron and a plate of copper in ordinary air, oxygen and carbonic acid makes the iron positively and the copper negatively electrified; but in sulphuretted hydrogen the iron becomes negative, and then the action ceases; the copper is covered by a thin coating of sulphur. The surrounding atmosphere, therefore, exercises an important influence on the generation of contact electricity.

EXCITATION OF ELECTRICITY BY PRESSURE AND FRICTION.—M. Herr H. Fritsch, of Konigsberg, gives in Wiedemann's *Annalen*, No. 9, 1878, the following interesting results educed by him. It is well known that certain crystalline bodies, such as cal spar, become electric by pressure when the pressure is applied by contact with a foreign material and not the substance itself. Thus two cal spars pressed together only show electrification at the surfaces in contact with the foreign bodies by which the pressure is exerted. It is generally stated that the electrification due to friction of two diverse substances depends exclusively on the nature of the substances, and M. Fritsch's experiments were undertaken to test the truth of this doctrine. Plates of zinc, copper, brass, and glass were stroked by him with a violin bow, so that they vibrated transversely and they became *negatively* electrified. But when the same bow was gently drawn lengthwise along the same part of the plate without producing a tone, the plate became *positively* electrified. When copper or zinc plates were whipped with white silk, so that the stroke was nearly perpendicular to the plate, the latter became strongly *positive;* if delivered so as to graze the plate it became as strongly *negative*. By *lightly* rubbing its entire rim with the silk it was always *negative;* but by *hard* rubbing of the rim with the same silk it was always *positive*. Coarse woollen cloth gave similar results in a less degree than silk. A square brass plate behaved like the copper plate; but a shallow scale pan of brass gave both electricities only when struck with silk and when well cleaned with acid. An old brass pound weight could not be excited at all with silk but only by a violin bow—the electricity varying according as it was applied to its broad base or its top. A small scale pan of silver gave both electricities only with silk, with wool it only became negatively electrified. A hard rubber plate always became negative when slowly stroked with a linen cloth lightly folded, and positive when quickly stroked. The surface of the hand produced the same effect as linen: only for the positive excitation the stroking had to be very rapid. White silk always made the principal cleavage surface of gypsum *positive;* but the subsidiary surface of lustrous fracture is always *negative*, while it makes no difference whether the latter surface is natural to the gypsum or is artificially produced by roughly scraping a surface of the principal cleavage plane. From a consideration of his experiments, M. Fritsch concludes that if two substances are rubbed against one another, the electricity excited in each of them may change into its opposite kind according as the pressure, velocity, or direction of the rubbing motion, &c., varies.

ELECTROLYTIC POLARIZATION.—Professor W. E. Ayrton and John Perry, from experiments carried on by sending a current from one or more Daniell cells through a voltameter and measuring its strength after a certain number of minutes, then suddenly reversing and observing the current strength a fixed time after, find that when the cathode is of copper wire, the anode being a copper plate, there is a quick falling off in the first current and a slow falling off in the reverse one; with a platinum wire cathode opposed to a platinum plate anode the reverse effect takes place; but with a platinum wire anode the same effect takes place. Messrs. Ayrton and Perry explain these facts by pointing out that since the surface of the wire in the voltameter is extremely small compared with that of the plate, the gases deposited on the wire will have more effect than those deposited on the plate in the polarization of the voltameter; and also that oxygen deposited on copper will, on account of its forming an oxide, be less operative in producing a reverse current than hydrogen; while on the other hand on account of the great absorption of hydrogen by platinum and of the difficulty of forming an oxide of platinum, it will be deposited oxygen that will produce the chief polarization in the platinum voltameter.

AN ELECTRICAL DIAPASON.—Mr. Geo. M. Hopkins, United States, has applied electricity to maintain the reeds in Lissajou's reflecting diapasons in constant vibration, for the production of Lissajou's figures. The reeds are adjustible as to length, so as to produce fractions of a tone and illustrate the phenomena of consonance and dissonance. In one form both reeds are conjoined to support a single mirror and give complex double tone figures.

PRODUCING THE ELECTRIC GLOW.—M. Boillot has invented an apparatus which gives a very bright glow in gases with a comparatively feeble electric tension. It consists of a glass tube 36 centimetres long and several millimetres internal diameter, filled with powdered

carbon, and hermetically closed; but having a platinum electrode sealed into one end. This fine tube is enclosed in a second medium sized tube so as to leave a very narrow annular space between. These concentric tubes are then enclosed in a third wider tube, and the space between the second and third tubes is also packed with powdered carbon. An electrode is also inserted into this carbon; and the ends of the latter are stiffened with shellac to prevent them falling out, for the extremities of this larger tube are open. Different gases are then passed up the annular space between the inner and middle tubes, and when the secondary poles of an induction coil, fed by several cells, are connected to the carbons, a phosphorescent glow is seen to traverse the gas all along the tubes. By means of a medium-sized induction coil and three or four Bunsen cells, M. Boillot has produced 50 milligrammes of ozone for every litre of oxygen gas submitted to the discharge.

ATMOSPHERIC ELECTRICITY.—In a recent article in *Appleton's American Popular Science Monthly*, Mr. Elisha Foote argues that when escaping steam infringes upon a conductor, the electricity generated in the latter is not due to friction, as Faraday believed, but to condensation of the steam. Blasts have been accidentally exploded by the steam from locomotives enveloping the naked wires of the electric fuse, and sparks have been observed on the switch board of railway telegraph offices when locomotives vented steam against the telegraph lines near by. These cases, however, speak at least as much for Faraday's explanation as Mr. Foote's.

MR. J. B. STEARNS has just succeeded in duplexing the Anglo-American Cable by his ordinary condenser system. The balance he has obtained, we understand, is absolutely complete, and the working of the siphon recorder (the instrument employed) is just as perfect as it was when single working was employed. Considering the marvellous sensitiveness of the siphon instrument this result is in the very highest degree satisfactory, and we congratulate Mr. Stearns on the success he has attained.

THE ELECTRIC LIGHT.—The New York papers announce that a new invention has been patented for the subdivision of the electric light by two electricians, named Sawyer and Man, of New York. The invention is said to be a very simple one, consisting of a small pencil of carbon little larger than a pin, and connected by wires with an electric machine enclosed in a hermetically-sealed glass globe filled with pure nitrogen gas. The new invention is known as the Electric Dynamite Light, and it is stated to emit a brilliant white light. The company asserts its ability to fit up lights equal to 30 gas, and state that by a very small switch in the wall the current of electricity can be divided so as to supply any number of burners. The meter difficulty has been overcome by an invention which will register the number of burners and the number of hours they are lighted. A company has been formed for the purpose of working the patent.

THE Leicester Corporation have resolved to obtain powers to light the city by electricity.

IT is proposed to test the electric light at Liverpool in front of St. George's Hall.

A MORE successful football match than that at the Oval was played in the old Deer Park at Windsor on Nov. 11. The light was supplied by two Siemens' machines, and two 50-cell batteries ranged along the sides of the field. No vain attempt was made, as at the Oval, to follow the ball, and the light was equable over the ground.

IT is stated that the Royal Docks at Flushing are to be lighted by 100 Werdermann lights. The same number will also be employed to light a portion of the city of Stockholm.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

THE USE OF THE MILLIWEBER.

SIR,—In the number of the *Journal Télégraphique* of March of this year, translated in your number of May 1st, M. Rothen, Assistant Director of Swiss Telegraphs, has questioned the policy and propriety of the introduction of the *milliweber* as a measure of the strength of currents used in telegraphy proposed by me in a paper read before the Society of Telegraph Engineers. His chief objection consists in deploring the destruction by me of the harmony and uniformity which exists in expressing other derivatives of the units in use by the submultiples *mega* and *micro*. But is this harmony and uniformity destroyed? I do not vary the unit. That has been fixed by the Committee of the British Association, and expressed by the Council of the Physical Society thus:—

"The practical unit of current is the current due to an electromotive force of 1 volt working through a resistance of 1 ohm. It is sometimes called the *weber*. We have

$$1 \text{ weber} = \frac{10^8}{10^9} = \frac{1}{10} \text{ of C G S unit of current."}*$$

Moreover the Committee of the British Association Committee on Units, in their first Report say, "For multiplication or division by a million the prefixes *mega* and *micro* may conveniently be employed according to the present custom of electricians . . . . . The prefixes *kilo, hecto, deca, deci, centi, milli* can also be employed in their usual senses before all new names of units."

In accordance with these views we use the microfarad, the megohm, the ohm, the volt, the milliweber, as the most convenient multiples and submultiples of the absolute units used in telegraphy. In other divisions of electrical science it is quite competent to use the farad, the hectohm, the decavolt, or the microweber, just as in mensuration we use the metre, millimetre, or centimetre, as it suits our convenience. We do not destroy harmony nor break through uniformity by doing so. General practice has confirmed the convenience of the milliweber in denoting the strength of working currents in telegraphic circuits, and I cannot admit that there is any inconsistency in adhering to this solution. The system has been introduced into the British Telegraph Department, and it is found to work very well and to be of very great convenience.

W. H. PREECE.

* Section 118. Illustrations of C G S system of units, published by the Physical Society of London.

TOMMASI'S RELAY.

[We were compelled in our last number from want of space to defer the particulars concerning the trial of this relay on the French Atlantic Cable, which were sent in by Mr. H. Weaver, general manager of that company. We are now able to give the substance of a report furnished to Mr. Weaver by the company's superintendent at Brest after M. Tommasi's official report to the French minister had been printed. It should be mentioned that M. Tommasi exhibits the supposed sensibility of his relay by working it through a block of dry wood; but the superintendent observed that this block of dry wood is plated with brass at its ends, and suggests that it therefore operates as a condenser.—Ed. TELE. JOUR.]

[COPY.]

THE ANGLO-AMERICAN TELEGRAPH CO., LT., BREST STATION.

1 *October*, 1878.

MEMORANDUM TO GENERAL MANAGER.

TOMMASI'S RELAY.

As before reported there is not only nothing new, but there is no merit whatever in Tommasi's Relay. In its construction the fundamental principles of electro-magnetism are violated, and instead of extreme sensibility (as claimed) it is not by any means so sensitive as two different models which I have tried, *and which have worked* as mirrors on the cable. The first plan is due to Mr. Varley, but was designed to overcome the "kicks" and large vibrations which we had during the existence of the two large faults (subsequently taken out); it worked well as a galvanometer, having a mirror attached to the steel needle. The second is Henley's relay, patented at least 25 years ago, and which I adopted with a mirror to work on the cable—this it did as well as Varley's instrument. In both these plans the magnetic alteration of the electro-magnet was utilised to the utmost, and there was but very little loss of power.

I now come to the veracious report, which is unveracious from what it conceals. We tried to work it *as a mirror with the full battery power* of 30 cells at S. P., and not a word could be read with it; two experienced clerks (Squires and Crilly) did their best, but could make out nothing but a letter here and there. The cause was, that to get signals the controlling magnet had to be so far removed, that definition was lost owing to want of sensibility. Not only was there this failure, but the needle being pivoted added its quota by continually "sticking" of its own accord.

Power was diminished to as low as 5 cells at S. P.—reading, of course, was out of the question, although it was tried, and all that was done was to count the number of right and left deflections, letter A or N in a minute; these were utterly unmeaning, as in no case would the deflection of the needle have sufficient force to make a relay contact the object of these experiments; the angular displacement of the needle would be hardly visible to the eye, although, of course, with the mirror attached, the deflection of the *spot of light* is large; however, we are not yet able to make contact with a spot of light, and until we can, a relay of *this* kind has not much chance.

As Mr. Tommasi throughout was so confident, although I told him at the outset that his relay would never work on this cable, I requested him to try it as *a relay—i. e.*, to make a contact. This was done with the full power at S. P. with the result that with the first current the needle hopelessly "stuck," and the *reverse current failed to detach it.* Here then the relay fails to do, under the best circumstances of power and no resistance in circuit, the very thing all these experiments are *made to show* that it *will* do. Now mark the contrast. With the Thomson galvanometer we *spoke* with L. P. with the lowest power used—viz., 5 cells and with no difficulty whatever, and without altering the adjustment used for 30 cells . . . To compare the sensibility of Tommasi's relay with Thomson's is an absurdity—the latter is at least ten times more sensitive.

The report to the Admiral (who was present) must be read between the lines, it only recounts what was seen, the deflections of the spot of light, and also what there was in the "Esprit de l'inventeur," of which there appears to be a good deal.

The Aide-de-Camp of the Admiral asked me in an aside what I thought of it. I replied that it would never work on this cable, and that there was no merit in it.

Mr. Tommasi, to judge from the memos attached, is evidently trying to make capital out of these previous experiments to the detriment of the company. On all sides I am raising enquiries if the relay has not had a great success on the Brest Cable. I think that if he should venture to ventilate these monstrosities in public he should be promptly extinguished.

I quite agree with you that "inventors" have too much indulgence from us. I think no experiments should be allowed on the cable until the instruments proposed have been examined by competent men, and their merits or otherwise established theoretically.

(Signed) THOS. ANDREWS.

New Patents.

4130. "Fog or alarm signals for the rails of railways." E. LUDLOW. Dated Oct. 17.

4161. "A commutator for double transmission and reversion of current with contact to earth for submarine telegraphy." E. EDMONDS (communicated by le Comte E. Siccardi). Dated Oct. 18.

4164. "Railway signalling." W. STRINGER and H. IVEY. Dated Oct. 19.

4173. "Means for signalling on board ship." G. C. PULFORD and H. J. BILLING. Dated Oct. 19.

4210. "Speaking telephones." J. F. BAILEY (communicated by G. M. Phelps). Dated Oct. 22.

4240. "Electric telegraph apparatus." W. R. LAKE (communicated by F. Tommasi). Dated Oct. 23.

4338. "Improvements in obtaining light by electricity, and in the means and apparatus employed therein." C. W. HARRISON. Dated Oct. 28.

4344. "Gas batteries for the production of electricity." F. J. ODLING. Dated Oct. 29.

4346. "Manufacture of telegraph cables." E. BERTHOUD and F. BOXEL. Dated Oct. 29.

4347. "Improvements in and appertaining to apparatus for producing the electric light." J. S. WILSON. Dated Oct. 29.

4367. "Improvements in electric telephony and apparatus therfore." J. F. BAILEY (communicated by F. L. Pope). Dated Oct. 29.

4388. "An improved method of and apparatus for producing electric light and regulating or controlling and measuring electrical currents for lighting, telegraphing, and other purposes." S. F. VAN CHOATE. Dated Oct. 31.

4403. "Apparatus for dividing and distributing currents of electricity." T. A. BELL. Dated Oct 31.

4407. "Applying electricity as a source of heat for industrial purposes." A. M. CLARK (communicated by C. Davis). Dated Oct. 31.

4438. "Improvements in preparing gutta-percha and other like substances suitable for insulating telegraphic conductors and for other purposes, and in machinery employed in the process and also improvements in making unions between various lengths of insulated conductors." E. J. TRUMAN. Dated Nov. 2.

4456. "Apparatus for producing, maintaining, and subdividing electric lights." F. H. W. NIGGINS. Dated Nov. 4.

4462. "Improvements in and appertaining to the production of the electric light." N. L. THOMSON. Dated Nov. 5.

4466. "Improvements in distributing electricity for the production of electric lights." C. STEWART. Dated Nov. 5.

4473. "Apparatus for obtaining electric light." F. GYE. Dated Nov. 5.

4476. "Means and apparatus for electric lighting." G. R. BODMER.

4502. "Lighting by electricity." G. G. BREWER (communicated by T. A. Edison). Dated Nov. 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

471. "Carbon electrodes." M. GRAY (communicated by N. E. Reynier, Paris.) Dated February 5, 1878. 2d. To avoid the useless combustion of carbon in electric lights, which takes place in rear of the luminous arc, it is proposed to plate them with some refractory metal, such as nickel or iron, by electrotyping. Nickel has the advantages of being cheap, easy of application, a high melting point, and little tendency to oxidise. The carbons are first smoothed with emery, cleaned, steeped in a lye of carbonate of soda or caustic potash, rinsed in water, electrotyped and dried at a temperature of over 100° F. *Not proceeded with.*

491. "Pneumatic Signal Bells." H. F. JOEL. Dated February 6, 1878. 6d. This consists of an improvement whereby an intermittent changing of a reciprocating into a circular motion is effected; and of an electric indicator, formed of a horse-shoe magnet, mounted on a fixed centre a little below the centre of gravity. When in its normal position the north and south poles are attracted by the sides of the cores of a small electro-magnet, such cores being connected by a cross-bar and enclosed by coils. The terminals of one coil are connected to the push battery bell; those of the other being connected severally to the adjusting button and the opposite pole of the battery.

492. "Battery Rheostats." SAMUEL JOSEPH COXETER. Dated February 6, 1878. 2d. This consists in forming resistances of powdered carbon or other conductor of electricity with powdered glass or other non-conductor of electricity. *Not proceeded with.*

570. "Gyrometers for Marine Engines." MORGAN BROWN (communicated by Schäffer and Budenberg, Buckan-Magdeburg, Prussia). Dated February 11, 1878. 6d. This consists of a dial which by means of a electro-magnetic connection with the engine informs the captain of the ship as to the working of the latter.

584. "Mode of Transmitting Audible Signals." HENRY EDMUNDS, Jun. Dated February 12, 1878. 6d. This consists in sending sound signals through water without a line. To communicate between the shore and a boat, a sounding apparatus, formed of a bell in a water-tight box, is sunk in the water, and the bell is worked mechanically or electrically from the shore. In the boat is a sound receiver which is dipped into the water, its upper end being brought near the ear of the listener. The pulsations of the bell are transmitted through the water from the shore apparatus to the boat. The pulsations may be received on an automatic recording apparatus. It is proposed to use this apparatus as a signal between ships at sea, or attached to buoys in still water near shoals; the bells being actuated by a sea-water battery and the alarm heard by the ship on applying a receiving apparatus, such as a spar of wood, to the water.

596. "Applying Electricity." EDWARD B. BRIGHT. Dated February 13, 1878. 6d. This consists in indicating the locality of an outbreak of fire by causing the thermostat or signal indicating the fire to insert distinctive resistances into the circuit at that point—these resistances indicating themselves at the fire station.

609. "Circuit Closers for Torpedoes." M. H. ATKINSON. Dated February 13, 1878. 8d. The closer is moored in an upright position beside the fuse, the circuit running through both. When the closer is forced out of its perpendicular position in the water by a ship the circuit is completed by a metal disc striking the outer case and the torpedo fired.

610. "Electric Apparatus for Mastering Horses." ADÈLE ENGSTRÖM. Dated February 13, 1878. 6d. This consists in applying a powerful current from an induction apparatus to the bit of a restive horse, so that the shock passes through the horse's mouth.

611. "Electric Telephonic Apparatus." PROF. G. BELL. Dated February 14, 1878. 6d. This consists in employing a tubular magnet in the Bell telephone, and in attaching the plate to the pole which was formerly unused. Another improvement is to attach the coil itself to the vibrating plate, so as to let the coil project from the plate and thereby cause both plate and coil to vibrate before the pole of the magnet.

617. "Telephones." H. J. HADDON (communicated by G. B. Richmond, Lansing, Mich., U.S.). Dated February 14, 1878. This consists of a telephone in which a platinum wire or style attached to the back of the diaphragm dips into water in front of a contact separated from it by a space of the liquid. The style and contact are in circuit with the line and a battery. When the diaphragm vibrates under the voice the style moves to and from the contact regulating the resistance of the intervening water and setting up undulatory voice currents received by an electro-magnetic telephone.

General Science Columns.

DEATHS.—Science has sustained two losses more, in the persons of Mr. Thomas Belt, F.G.S., and Mr. Thomas Grubb, F.R.S. Mr. Belt is best known as the author of the "Naturalist in Nicaragua." He was an engineer as well as an able geologist and traveller. He died in Colorado. Mr. Grubb, the well-known mechanician, was originally destined for commercial pursuits, but naturally inclined towards science. He displayed marked originality of invention in the designs of his instruments and the equipment of astronomical and magnetic observatories. He was elected a Fellow of the Royal Society in 1864, on his completion of the great Melbourne telescope. Dr. Peterman, the eminent geographer of Gotha, is also dead.

MECHANICAL EQUIVALENT OF HEAT.—The newest value of Joule's equivalent, as given by Dr. Joule, from the experiments of the Special Committee of the British Association for its determination, is as follows:—The heat required to raise a pound of water, weighed in vacuo, from a temperature of 60° to 61° Fahrenheit at the sea level in the latitude of Greenwich, is equivalent to 772·55 foot pounds of work done. The committee are now engaged in determining the true position of the freezing and boiling points of the thermometer when the effects of imperfect elasticity of the glass are eliminated.

THERE is said to be a terrestrial globe in the Jesuitic Library of the Lyons Lyceum, made in 1701 by two Brothers of the Third Order of St. Francis, which delineates in detail the great central African lake system recently explored by English and American travellers.

PHYSICAL ORIGIN OF NEBULAE.—In a recent paper on this subject, Dr. Croll endeavours to attribute the origin of the sun's heat and formation of nebulae to the collision of bodies in space. He shows that were the origin of the solar heat referred to gravitation, the other tenable hypothesis, the amount of energy from that source could not keep up the present radiation from the sun beyond 20 or 30 million years; whereas the mere collision of two bodies each one-half the mass of the sun and moving at a velocity of 476 miles per second, would generate an amount of heat capable of supporting the present solar radiation for 50 million years. Each pound of the mass would, by the stoppage of its motion, possess heat enough to melt 90 tons of iron; and the whole mass would be converted into an incandescent gas or nebulae, with a temperature of certainly more than 140,000 times that of the voltaic arc.

SPEAKING MACHINES.—As a contribution to the history of the phonograph and megaphone, we give the following quaint extract from the "Natural Magick" of John Baptista Porta, a Neapolitan, London, 1658. In the 19th book he says, "I have read that in some Cities there was a Colossus of Brass placed on a mighty high Pillar, which in violent tempests of wind from the nether parts received a great blast that was carried from the mouth to a Trumpet, that it blew strongly, or else sounded some other instrument, which I believe to have been easie, because I have seen the like. Also, I read in many great men of authority, that *Albertus Magnus* made a head that spoke; yet, to speak truth, I give little credit to that man, because all I made trial of from him I found to be false but what he took from other men. I will see whether an Image can be made that will speak. Some say that *Albertus* by Astrological elections of times, did perform this wonderful thing; but I wonder how learned men could be so gulled, for they know the stars have no such forces. Some think he did it by Magick Arts. And this I credit least of all, since there is no man that possesseth himself to know those Arts but Impostors and Mountebanks, whilst they cheat ignorant men and simple women, nor do I think that the Godly man would possess ungodly Arts. But I suppose it may be done by wind. We see that the voice or a sound will be conveighed entire through the Air, and that not in an instant, but by degrees in time. We see that Brass guns, which by the force of Gunpowder make a mighty noise, if they be a mile off, yet we see the flame much before we hear the sound. So hand Guns make a report that come at a great distance to us, but some minutes of time are required for it, for that is the nature of sounds; wherefore sounds go with time, and are entire without interruption, unless they break upon some place. The Echo proves this, for it strikes whole against a wall, and so rebounds back, and is reflected as a beam of the Sun. Moreover, as I said in this work, words and voices go united together, and are carried very far entire, as they are spoken at first. These, therefore, being laid down for true grounds, if any man shall make leaden Pipes exceeding long, two or three hundred paces long (as I have tried), and shall speak in them some or many words, they will be carried true through those Pipes, and may be heard at the other end, as they came from the speaker's mouth; wherefore, if that voice goes with tune, hold entire, if any man as the words are spoken, shall stop the end of the Pipe, and he that is at the other end shall do the like, the voice may be intercepted in the middle, and be shut up as in a prison and when the mouth is opened, the voice will come forth, as out of his mouth that spake it; but because such long Pipes cannot be made without trouble, they may be bent up and down like a Trumpet, that a long Pipe may be kept in a small place; and when the mouth is open, the words may be understood. I am now upon trial of it; if before my Book be Printed the business take effect, I will set it down; if not, if God please, I shall write of it elsewhere."

On the megaphone, the learned Porta is equally ingenious, but not quite so happy. He says, "In my Opticks I showed you spectacles, wherewith one might see very far. Now I will try to make an Instrument, wherewith we may hear many miles; and I will search out a wood, wherewith that may be performed better and with more ease. Therefore to find out the form of this Instrument, we must consider the ears of all living creatures, that hear best. For this is confirmed in the Principles of Natural Philosophy, that when any new things are to be invented, Nature must be searched and followed. * * * And *Aristotle* saith that Horses, Asses, Dogs, and other Creatures that have great ears, do always stir them about, and turn them to hear noise, Nature teaching them the use of those parts; and we find that they hear less that have their ears cut off: wherefore it is fit that the Form of the Instrument for hearing be large, hollow, and open, and with screws inwardly. For the first, if the sound should come indirectly, it would hurt the sense; for the second, the voice coming in by windings is beaten by the turnings in the ears, and is therefore multiplied, as we see in an echo. The sea-Periwinkle is an argument to prove it, which, being held to the ear, makes a light noise. Now it remains to speak of what matter it must be made. I think of porous Wood, for the holes and pores are passable every way; and being filled with air, they sound with every small stroke; and amongst the porous Wood, is the Ivy, and especially the tree called Smilac, or Woodbind, for a Dish made with Ivy, will let out water, as I said. Wherefore *Pliny*, speaking of the Woodbind, saith, "It is proper to this matter, that being set to the ears, it will make a small noise." And in another place, I said that the Woodbind, Ivy, would sound, if set to the ear. Therefore fit your Instrument to put into your ear, as spectacles are fitted to the eyes."

EDISON'S "BLIND" INK.—This ink, which swells up on hardening so as to be in relief from the paper, is now being tried on wood, and it is thought that a variety may be found which will be hard enough to print from, so that artists may draw their designs with it, and dispense with the engraver.

SCHNEIDER'S TELESCOPE.—We learn from an Austrian journal *(Bericht der K. K. Academic der Wis-*

chenschaften) that M. Schneider, a mechanician of Vienna, has invented a telescope which enables an observer to see simultaneously and distinctly, without altering the distances of the lenses, two different objects in the same line, one very near, and the other at a great distance. The priority of the invention is attested by the Vienna Academy of Sciences. We believe that Newton, Gallileo, Frauenhofer and Ploessal, have attempted in vain to construct a telescope of this sort. Schneider's telescope cannot fail to be useful, not only in astronomical and in naval or military observations, but in surveying and in physical experiments. If the same principle can be applied to the microscope it will be of great value for comparing specimens. Will some of our optical specialists give us their opinion of this invention?

THE MILK OF THE COW-TREE.—No tree aroused the imagination of Humboldt so keenly as the *Broximum Galactodendron*; or *palo de leche*, or cow-tree, which grows upon the slopes of the cordilleras of Venezuela. As the nutricious juice of this tree is allied very closely to the rubber tree of Brazil—and, indeed, may yet come to supply a rubber to the European markets—the following account of its composition, communicated to the French Academy of Sciences by M. Boussingault, may not be without interest. The cow-tree grows to a height of from 15 to 20 metres; its leaves are oblong, alternate, and terminated by points. The creamy juice is obtained by cutting into the inner bark. It is used by the natives in place of cow's milk. The analysis of 100 parts of milk, containing 42 parts of fixed matter, is as follows:

Wax and saponaceous matter ...	35·2	
Sugary substances	2·8	
Caseine, albumen	1·7	4·0
Earths, alkalies, phosphates ...	0·5	
Indeterminate substances	1·8	
Water	58·0	
	100·0	

The cream of the cow, according to an analysis of M. Jeannier, contains:

Butter	34·3
Milk sugar	4·0
Caseine and phosphate	3·5
Water	58·2
	100·0

It will be observed that wax appears in the vegetable milk in about the same proportion as butter in the animal.

City Notes.

Old Broad Street, November 12, 1878.

THE tenth ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Company (Limited), was held on the 6th inst. at the City Terminus Hotel, under the presidency of Mr. John Pinder, M.P. The report of the directors, which was mentioned in our last issue, was taken as read.—The Chairman, in moving its adoption, said he was glad to be able to congratulate the shareholders on the fact that their cables were to-day in good working order, which they had not been very often able to say during the last six months. At the present time the traffic was going on in a very satisfactory way. The gross earnings for the half-year ending 30th June last were £135,482, which as against £140,436 earned in the corresponding period of last year showed a decrease of £4,954. Of this amount nearly £2,000 was lost in exchange, and the remainder was due to a slight falling off in revenue, which he was glad to say had been made up since the close of the half-year. The expenditure in the same time time had been £61,222, as against £48,417 in 1877, an increase to the extent of £12,805. This was accounted for in the following manner:—Station expenses caused principally by the opening of the Rangoon cable, staff for a night service during the Eastern crisis, and establishment of the duplex working on the Madras-Penang line, £2,690; expenses of conference at Melbourne, £898, and cost of new land lines and instruments for establishment of duplex system, £4,342. Those were sums that would not have to be repeated. The duplex system practically gave them for working purposes an additional cable, as they were able to send simultaneously from either end, both messages going forward at the same time. The heavy amount of over £3,000 for repairs was caused to a considerable extent by the well-known "teredo," which was found in shallow water. The result of its ravages was that they had to make repeated repairs, small in themselves; but still damage to the extent of a pin's point caused as much interruption as if the cable were cut to pieces. They had turned a great deal of attention to this subject, and in connection with the Telegraph Construction Company, had now got something like 150 miles of experimental cable being tried, which he believed it would be impossible for any insects to penetrate. If so it would prevent a constant drain upon their resources. The depreciation of ships was £2,000, and this amount would continue until they were brought down to the price at which they could be at any time sold. The net revenue was £74,260, or a decrease of £17,759 on the corresponding six months of 1877. After paying the two interim dividends they carried forward £24,323 as against £13,299. Their new ship, the *Sherard Osborn*, which had cost them £45,000, had now arrived at her station, where she had already been of great service. The question that the directors expected to have brought forward to-day at the special meeting—the duplication of the Australian Cable—was one that they would have to postpone for a short time. They had received telegrams from time to time from Colonel Glover, who was now in Australia, to the effect that he had got the different Governments of the Colonies to agree to the duplications and to pay £32,000 a year. They had brought the matter to such a satisfactory point that they had intimated they were going that day to take powers to carry it out. Colonel Glover was assured by the Government of New South Wales that the terms were approved, but they had to be affirmed by the Parliaments of Victoria and New South Wales. The former did so unanimously, but the latter, ofter two nights' discussion made some alterations that had to be referred to the Senate, who made still further alterations, so that the agreement which the directors expected to read that day as complete was now in abeyance. He (the chairman) had no doubt that they would arrive at a satisfactory conclusion in the course of a week or ten days, and he therefore thought they had better not discuss the matter until the directors were ready with an agreement to which they would ask approval.—The Right Hon. W. N. Massey, M.P. (vice-chairman): I beg leave to second that. Some discussion then followed upon the accounts, in which Mr. Marshall, Mr. Christie, Mr. Abbott, and Mr. Newton took part.—Mr. Marshall: May I ask whether any other tenders have

been asked for than from the Construction Company for the new cable? It is an important question.—The Chairman replied by saying: It is a very important question indeed for the shareholders to have a cable in which they and the directors can have perfect confidence (hear, hear) and therefore I am prepared to answer, so far, your question. We have not asked for tenders from any other company but the Construction Company (hear, hear). We shall get a special cable manufactured, and have requested one of the leading firms of electrical engineers of London—Messrs. Clark and Ford—to go most carefully into the cost of the cable, taking the whole of the different materials into account and they have given us a certain sum. We also got Sir James Anderson, who has a technical knowledge of the value of these different articles to go into it, and these gentlemen came to within £8,000 of each other as to the cost of the cable. I may tell you that, when we do make a contract for the cable, we shall save very considerably upon the estimate of the value of the cable that we got from our engineers, and also from Sir James Anderson. Having said so much, I think it must satisfy you that we have looked to quality, and we have looked to another thing. I hope that these debentures will be floated at 5 per cent., and our arrangement will be with the contractor that, if there is any difficulty at all in floating them, they will be ready to aid us in the transaction (hear, hear). I can only tell you that, from the experience I have had of getting cables from other parties, I am here to prove by experts that what we have done with the Construction Company is cheaper and more satisfactory to us than you could have dealt elsewhere (hear, hear). With these remarks, I beg to take the sense of the meeting on the resolution before them. Those who approve of it will please to signify the same in the usual way—— on the contrary. It is carried with one dissentient. The business of this meeting is closed, and we come to the extraordinary general meeting, and I beg to propose "That the extraordinary general meeting be adjourned to Wednesday, December 4, at 2 p.m., at the Terminus Hotel, Cannon Street." Lord William Montagu Hay having seconded the proposition, the chairman then put the resolution to the meeting in the usual way for and against, and it was carried. He then said: That is all the business, gentlemen, and I hope that when we meet a month hence we shall be able to state that the contract is settled with Australia; and I would just say one word in regard to the contract—that I am perfectly satisfied that, if it is carried out in the terms and in the spirit which your directors have before them, it will give you an additional security, and I hope will materially develope the traffic between this and Australia. The Australians are so alive to the value of telegraphic communication with England that, as one of the speakers pointed out, as being a thing unknown to the colony before, they have really united to subscribe an annual sum for a duplicate cable, so as to ensure that continuous communication with England which they so much value. That continuous connection with England will give, at all events, an additional security to you (hear, hear). A vote of thanks was tendered to the Board of Directors for their able management of the Company's business.

The Direct United States Cable Company notify on and after the 16th inst., the payment of an *interim* dividend of 5s. per share, being at the rate of 5 per cent. per annum, for the quarter ending 30th September.

The Stock Exchange Committee have allowed 1,500 ordinary and 1,500 preference additional shares of the Globe Telegraph and Trust Company (Limited) to be added to the 154,000 shares of each class already in the official list.

Notification was given on the 4th inst. of the restoration of the Eastern Extension Telegraph Company's Java-Singapore Cable; also on the same date of the Great Northern Company's Amoy-Shanghai Cable, thus re-establishing direct telegraphic communication with Java, Australia, and Shanghai *via* Eastern.

Gas shares have slightly recovered from the tremendous depression noticeable when last we wrote. During the week just ended Gas Light and Coke A ordinary rose 7; ditto H preference, 2; Commercial, Imperial, Continental, and London, 5; Bombay, Continental Union, European, and Para shares, ¼.

We think a considerable advance has been effected in the matter of electric lighting by M. Werdermann, whose system is given fully in another column, and we shall be interested to note what success it achieves when his lamps are placed at some distance from each other.

Much has been asked and said about the cost of the electric light when compared with that of gas. We have seen no figures relating to this subject on which much value can be set. Even usually well-informed journals have published comparisons on the subject, omitting altogether charges for interest on capital expended for machines, motive power, &c. As the various machines, lamps, and appurtenances are improved the figures change rapidly; the subject is, therefore, a rather difficult one to analyse. Most of the data given have been quoted by sellers and not users of the apparatus, and, without thinking for a moment that our large manufacturing firms would consciously mislead the public, it is but natural to assume that the most favourable colouring consistent with truth has been given to their reports hitherto published. In making a comparison, the cost of machines, lamps, conductors and motive power, must be ascertained, and the interest on this amount, together with the cost of skilled employees, lubricants, carbons, renewals of brushes, and allowance for depreciation generally, set against the price of gas for a similar lighting power, which price will include the whole cost, excepting only the fittings of the consumer.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 59½-60; Ditto, Preferred, 85-86; Ditto, Deferred, 34⅛-35⅛; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅜-6⅝; Cuba, Limited, 8-8½; Cuba, Limited, 10 per cent. Preference, 15¼-15¾; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 9½-10 xd.; Direct United States Cable, Limited, 1877, 12¾-13; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures repayable October, 1883, 103-106; Eastern 5 per cent. Debentures repayable August, 1887, 98-100; Eastern, 6 per cent. Preference, 10⅞-11⅛; Eastern Extension, Australasian and China Limited, 7-7⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 102-105; German Union Telegraph and Trust, 7¾-8⅛; Globe Telegraph and Trust, Limited, 4¾-5; Globe, 6 per cent. Preference, 10¼-10½; Great Northern, 7⅝-7¾; Indo-European, Limited, 18½-19½; Mediterranean Extension, Limited, 2⅝-3⅛; Mediterranean Extension, 8 per cent. Preference, 8¾-9⅛; Reuter's, Limited, 9⅛-10⅛; Submarine, 215-220; Submarine Scrip, 1⅝-2⅛; West India and Panama, Limited, 1⅝-2⅛; Ditto, 6 per cent. First Preference, 7⅜-8⅛; Ditto, ditto, Second Preference, 7⅛-8; Western and Brazilian, Limited, 2⅜-3; Ditto, 6 per cent. Debentures "A," 88-93, Ditto, ditto, ditto, "B," 84-88; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds; 108-112; Ditto, 6 per cent. Sterling Bonds, 100-102; Telegraph Construction and Maintenance, Limited, 29⅛-30⅛; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅛-2⅜; India Rubber Co., 29-30.